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WMP-29683
Revision 0

Borehole Summary Report for Well 299-W11-45 (C4948), ZP-1 Operable Unit

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Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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GRAAM, Inc.

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ACRONYMS

bgs	below ground surface
btoc	below top of casing
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
DOE-RL	U.S. Department of Energy-Richland
DOW	Description of Work
DQO	Data Quality Objectives
EPA	U.S. Environmental Protection Agency
FFS	Fluor Federal Services
FH	Fluor Hanford, Inc.
gpm	gallons per minute
GPS	Global Positioning System
HWIS	Hanford Well Information System
ID	inside diameter
NAD83 (91)	North American Datum of 1983 (1991)
NAVD88	North American Vertical Datum of 1988
NMLS	Neutron Moisture Logging System
NTU	Nephelometric Turbidity Unit
OD	outside diameter
OU	Operable Unit
PNNL	Pacific Northwest National Laboratory
psi	pound per square inch
SAP	Sampling and Analysis Plan
SGLS	Spectral Gamma Logging System
toc	top of casing
RCW	*Revised Code of Washington*
RLM	Ringold Lower Mud
WAC	*Washington Administrative Code*

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METRIC CONVERSION CHART

Into Metric Units

If You Know	*Multiply By*	*To Get*
Length		
inches	25.4	millimeters
inches	2.54	centimeters
feet	0.305	meters
yards	0.914	meters
miles	1.609	kilometers
Area		
sq. inches	6.452	sq. centimeters
sq. feet	0.093	sq. meters
sq. yards	0.0836	sq. meters
sq. miles	2.6	sq. kilometers
acres	0.405	hectares
Mass (weight)		
ounces	28.35	grams
pounds	0.454	kilograms
ton	0.907	tonne
Volume		
teaspoons	5	milliliters
tablespoons	15	milliliters
fluid ounces	30	milliliters
cups	0.24	liters
pints	0.47	liters
quarts	0.95	liters
gallons	3.8	liters
cubic feet	0.028	cubic meters
cubic yards	0.765	cubic meters
Temperature		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius
Radioactivity		
picocuries	37	millibecquerel

Out of Metric Units

If You Know	*Multiply By*	*To Get*
Length		
millimeters	0.039	inches
centimeters	0.394	inches
meters	3.281	feet
meters	1.094	yards
kilometers	0.621	miles
Area		
sq. centimeters	0.155	sq. inches
sq. meters	10.76	sq. feet
sq. meters	1.196	sq. yards
sq. kilometers	0.4	sq. miles
hectares	2.47	acres
Mass (weight)		
grams	0.035	ounces
kilograms	2.205	pounds
tonne	1.102	ton
Volume		
milliliters	0.033	fluid ounces
liters	2.1	pints
liters	1.057	quarts
liters	0.264	gallons
cubic meters	35.315	cubic feet
cubic meters	1.308	cubic yards
Temperature		
Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity		
millibecquerel	0.027	picocuries

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1.0 INTRODUCTION

This report describes the 2005/2006 fiscal year field activities associated with the installation of a single monitoring well drilled down-gradient of Waste Management Area (WMA) T in the 200 West Area to support the WMA T groundwater assessment. This groundwater monitoring well was installed for Fluor Hanford, Inc. (FH) in accordance with in the *Tri-Party Agreement* (Ecology et al. 1989) Milestone M-024-57, the Sampling and Analysis Plan (SAP) (DOE-RL 2005), and the Description of Work (DOW) (FH 2005). Drilling data for this well are summarized in Table 1-1. Documents supporting field activities as well as procedures followed during borehole characterization and well construction are listed in Section 7.0 of this document.

1.1 BACKGROUND

WMA T is located in the central part of the 200 West Area. Single-shell tanks (SSTs) located within WMA T still contain fairly large amounts of radioactive and hazardous chemical waste in both liquid and solid form that was generated from T-Plant processes during the production and separation of plutonium between 1948 and 1956. WMA T is still holding approximately 241,000 gallons of liquid waste and 1,825,000 gallons of solids in the form of sludge and salt cake (HNF-EP-0182, *Waste Tank Summary Report for Month Ending January 31, 2006*).

The SSTs located within WMA T are hazardous waste management units regulated under the *Resource Conservation and Recovery Act* of 1976 (RCRA), the Washington State "Hazardous Waste Management" (*Revised Code of Washington* [RCW] 70.105) and it's implementing requirements (*Washington Administrative Code* [WAC] 173-303, "Dangerous Waste Regulations"). Groundwater monitoring at the WMA T is regulated under RCRA interim-status regulations (40 *Code of Federal Regulations* (CFR) 265, Subpart F, by reference of *Washington Administrative Code* WAC 173-303-400[3]). Assessment groundwater monitoring was initiated because of elevated specific conductance values detected in down-gradient wells (BHI-01518, *Description of Work for Calendar Year 2001 RCRA Drilling*).

In 2000, four wells were installed outside the T tank farm (PNNL-13590, *Borehole Data Package for Calendar Year 2000-2001 RCRA Wells at Single-Shell Tank Waste Management Area T).* In 2001, one well was installed outside the T tank farm (PNNL-13830, *Borehole Data Package for Calendar Year 2000-2001 RCRA Wells at Single-Shell Tank Waste Management Area T).* In 2005, well 299-W11-25B (C4669) was drilled and later decommissioned due to complications encountered during well completion. Also in 2005, well 299-W11-46 (C4950) was drilled and completed as a replacement well for 299-W11-25B (C4669) (WMP-20073).

1.2 PURPOSE AND SCOPE

The primary purpose of this field effort was to install a single monitoring well East of WMA T in the 200 West Area. This well will provide down-gradient groundwater monitoring coverage and input data for groundwater flow models. The scope of activities described in this report includes the technical data that encompasses the drilling of a single borehole and related well construction. Additional scope of work described in this report includes waste management and subsurface descriptions. All drilling data in this report are presented in the units in which they were measured in the field, with the exception of survey data where applicable which are

reported in metric units. A summary of the new monitoring well is provided in Table 1-1 and the location of the well is shown in Figure 1-1.

Table 1-1. Drilling Summary of Borehole and Well

Well Name/Well ID	Area	Drilling Date		Northing (m)	Easting (m)	Ground Surface Elevation[a] (Brass Cap) (m)	Total Depth (feet bgs)
		Start	Finish				
299-W11-45/ C4948	ZP-1 OU	9/2/05	3/9/06	136775.64	566992.84	212.884	438

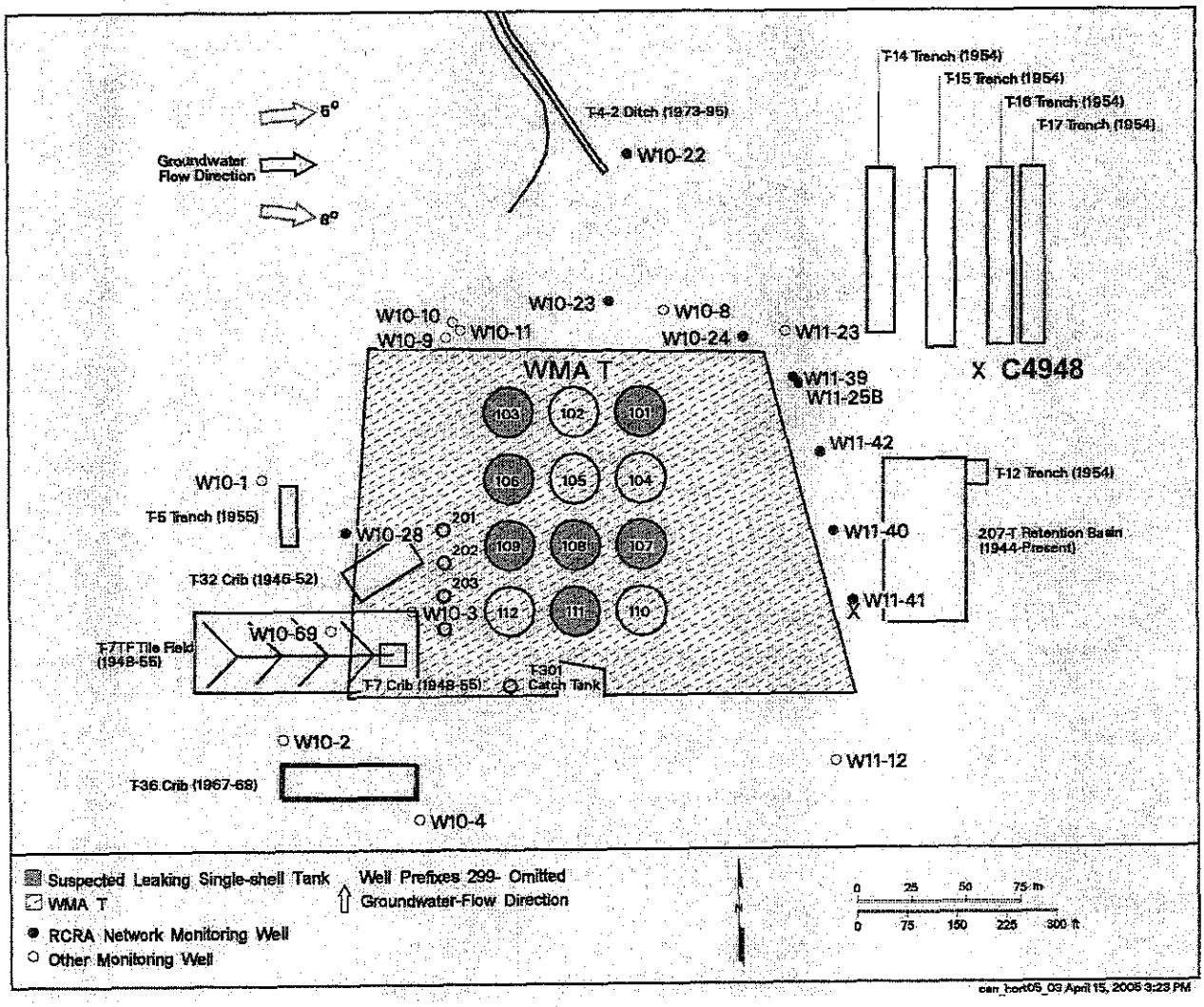
Notes:

Northing and easting coordinates are based on Washington State Plane Coordinates North American Datum of 1983 (NAD83[91]) rounded to 1 m.

[a] North American Vertical Datum of 1988 (NAVD88) values rounded to 0.001 m.

bgs = below ground surface.

Figure 1-1 Location Map for Monitoring Well 299-W11-45 (C4948) in the ZP-1 Operable Unit



2.0 TECHNICAL DATA

This section provides technical details of the drilling methods, well completion, well development, and pump installation activities performed during construction of the groundwater monitoring well in the ZP-1 OU (see Figure 1-1). Drilling data are presented in Table 1-1 and well summary information is located in Appendices A through D.

2.1 ZP-1 OPERABLE UNIT

2.2 WELL 299-W11-45 (C4948)

This section summarizes activities related to the construction of groundwater compliance monitoring well 299-W11-45 (C4948).

2.2.1 Drilling Summary

Drilling of Well 299-W11-45 (C4948) began on September 2, 2005 using a cable tool drill rig, driving single wall carbon steel temporary casing with a 13 3/8 inch outside diameter (OD) and 12 1/8 inch inside diameter (ID) to a depth of 196.5 ft below ground surface (bgs). Below 196.5 bgs the casing was downsized to single wall carbon steel temporary casing with a 10 ¾ inch OD and 9 1/4 inch ID that was driven to a depth of 436.2 ft bgs. The borehole was advanced using both core barrel and hard tool drilling methods to a total depth (TD) of 438 ft bgs on November 15, 2005. The water table was initially encountered at approximately 253.2 feet bgs on September 23, 2005.

2.2.2 Sample Summary

Multiple water samples were collected from 259.5 – 438 feet bgs and tested for various chemical properties by Pacific Northwest National Laboratory (PNNL) and FH. Archive samples (1-pint glass jars) were collected for FH and PNNL, at five-foot intervals, but were not analyzed in the field. In addition to the archive samples, lithologic changes were recorded and collected in plastic chip trays for future characterization use by both FH and PNNL. Table 2-1 summarizes the water sampling for Well 299-W11-45 (C4948).

Table 2-1. Water Sample Summary for Well 299-W11-45 (C4948)

Sample Number	Sample Date	Sample Method	Kabis Depth (ft bgs)	Pump Intake (ft bgs)	Sample Depth (ft bwt)	Borehole Depth (ft bgs)	Casing Depth (ft bgs)	Open Interval (ft)
B1DN10	26-Sep	Kabis	259.5	N/A	6.5	260	260	0
B1DWX8	29-Sep	Bail/Kabis	263	N/A	10	263	263	0
B1DWY0	29-Sep	Bail/Kabis	263	N/A	10	263	263	0
B1DWY2	29-Sep	Bail/Kabis	263	N/A	10	263	263	0
B1DWY4	29-Sep	Bail/Kabis	263	N/A	10	263	263	0
B1DN05	29-Sep	Bail/Kabis	263	N/A	10	263	263	0
B1DN06	29-Sep	Bail/Kabis	263	N/A	10	263	263	0
B1DWY2	29-Sep	Bail/Kabis	263	N/A	10	263	263	0
B1DWY4	29-Sep	Bail/Kabis	263	N/A	10	263	263	0
B1DN08	29-Sep	Kabis	268	N/A	15	268	268	0
B1DN12	29-Sep	Kabis	268	N/A	15	268	268	0
B1F5P9	4-Oct	Bailer	N/A	N/A	20	274	263	11
B1DN13	4-Oct	Bailer	N/A	N/A	20	274	263	11
B1DN45	4-Oct	Bailer	N/A	N/A	20	274	263	11
B1DN56	4-Oct	Bailer	N/A	N/A	20	274	263	11
B1DN67	4-Oct	Bailer	N/A	N/A	20	274	263	11
B1DN78	4-Oct	Bailer	N/A	N/A	20	274	263	11
B1DN03	6-Oct	Pump	N/A	272	25	279	273	6
B1DN04	6-Oct	Pump	N/A	272	25	279	273	6
B1DN05	6-Oct	Pump	N/A	272	25	279	273	6
B1DN06	6-Oct	Pump	N/A	272	25	279	273	6
B1DN11	6-Oct	Kabis	278	N/A	25	279	273	6
B1DN14	6-Oct	Kabis	278	N/A	25	279	273	6
B1DN46	7-Oct	Pump	N/A	281.6	30	283.6	279.5	4.1
B1DN 57	7-Oct	Pump	N/A	281.6	30	283.6	279.5	4.1
B1DN68	7-Oct	Pump	N/A	281.6	30	283.6	279.5	4.1
B1DN79	7-Oct	Pump	N/A	281.6	30	283.6	279.5	4.1
B1DWX9	7-Oct	Pump	N/A	281.6	30	283.6	279.5	4.1
B1DWY1	7-Oct	Pump	N/A	281.6	30	283.6	279.5	4.1
B1DWY3	7-Oct	Pump	N/A	281.6	30	283.6	279.5	4.1
B1DWY5	7-Oct	Pump	N/A	281.6	30	283.6	279.5	4.1
B1DN16	11-Oct	Kabis	288	N/A	35	288	288	0
B1F856	11-Oct	Kabis	293	N/A	40	294	293	1
B1DN17	11-Oct	Kabis	293	N/A	40	294	293	1
B1DN47	11-Oct	Pump	N/A	291.5	40	294	293	1
B1DN57	11-Oct	Pump	N/A	291.5	40	294	293	1
B1DN69	11-Oct	Pump	N/A	291.5	40	294	293	1
B1DN80	11-Oct	Pump	N/A	291.5	40	294	293	1
B1DN18	12-Oct	Kabis	297	N/A	45	298	298	0

Table 2-1. Water Sample Summary for Well 299-W11-45 (C4948)

Sample Number	Sample Date	Sample Method	Kabis Depth (ft bgs)	Pump Intake (ft bgs)	Sample Depth (ft bwt)	Borehole Depth (ft bgs)	Casing Depth (ft bgs)	Open Interval (ft)
B1DN19	12-Oct	Kabis	297	N/A	45	298	298	0
B1DN48	13-Oct	Pump	N/A	300	50	302.7	302.5	0.2
B1DN59	13-Oct	Pump	N/A	300	50	302.7	302.5	0.2
B1DN70	13-Oct	Pump	N/A	300	50	302.7	302.5	0.2
B1DN81	13-Oct	Pump	N/A	300	50	302.7	302.5	0.2
B1DN20	17-Oct	Kabis	308	N/A	55	308.6	308	0.6
B1DN21	17-Oct	Kabis	313	N/A	60	314	312.5	1.5
B1DN49	17-Oct	Pump	N/A	311.5	60	314	312.5	1.5
B1DN60	17-Oct	Pump	N/A	311.5	60	314	312.5	1.5
B1DN71	17-Oct	Pump	N/A	311.5	60	314	312.5	1.5
B1DN82	17-Oct	Pump	N/A	311.5	60	314	312.5	1.5
B1DN15	18-Oct	Kabis	317	N/A	65	318.5	318	0.5
B1DN22	18-Oct	Kabis	317	N/A	65	318.5	318	0.5
B1DN23	18-Oct	Pump	N/A	305	70	323	322.5	0.5
B1DN24	19-Oct	Kabis	327	N/A	75	327.8	327.8	0
B1FCX1	20-Oct	Pump	N/A	311.5	80	333	332.5	0.5
B1DN50	20-Oct	Pump	N/A	311.5	80	333	332.5	0.5
B1DN61	20-Oct	Pump	N/A	311.5	80	333	332.5	0.5
B1DN50	20-Oct	Pump	N/A	311.5	80	333	332.5	0.5
B1DN50	20-Oct	Pump	N/A	311.5	80	333	332.5	0.5
B1DN72	20-Oct	Pump	N/A	311.5	80	333	332.5	0.5
B1DN83	20-Oct	Pump	N/A	311.5	80	333	332.5	0.5
B1DN26	20-Oct	Kabis	337.4	N/A	85	338.4	338	0.4
B1DN27	21-Oct	Pump	N/A	323	90	343	342.5	0.5
B1DN28	25-Oct	Kabis	348	N/A	95	348	342.5	5.5
B1FJL6	26-Oct	Pump	N/A	339	100	352.5	352.5	0
B1FJL7	26-Oct	Pump	N/A	339	100	352.5	352.5	0
B1DN51	26-Oct	Pump	N/A	339	100	352.5	352.5	0
B1DN62	26-Oct	Pump	N/A	339	100	352.5	352.5	0
B1DN73	26-Oct	Pump	N/A	339	100	352.5	352.5	0
B1DN84	26-Oct	Pump	N/A	339	100	352.5	352.5	0
B1DN30	26-Oct	Kabis	358	N/A	105	358	358	0
B1DN31	27-Oct	Pump	N/A	339	110	363	362.5	0.5
B1DN32	27-Oct	Kabis	368	N/A	115	369	369	0
B1FRC2	28-Oct	Pump	N/A	355	120	373	372.5	0.5
B1DN52	28-Oct	Pump	N/A	355	120	373	372.5	0.5
B1DN63	28-Oct	Pump	N/A	355	120	373	372.5	0.5
B1DN74	28-Oct	Pump	N/A	355	120	373	372.5	0.5
B1DN85	28-Oct	Pump	N/A	355	120	373	372.5	0.5
B1DN34	31-Oct	Kabis	377	N/A	125	378	378	0
B1DN35	31-Oct	Pump	N/A	370	130	383	382.5	0.5
B1DN36	1-Nov	Kabis	388	N/A	135	388	388	0

Table 2-1. Water Sample Summary for Well 299-W11-45 (C4948)

Sample Number	Sample Date	Sample Method	Kabis Depth (ft bgs)	Pump Intake (ft bgs)	Sample Depth (ft bwt)	Borehole Depth (ft bgs)	Casing Depth (ft bgs)	Open Interval (ft)
B1FRV0	1-Nov	Pump	N/A	370	140	393	392.5	0.5
B1DN53	1-Nov	Pump	N/A	370	140	393	392.5	0.5
B1DN64	1-Nov	Pump	N/A	370	140	393	392.5	0.5
B1DN75	1-Nov	Pump	N/A	370	140	393	392.5	0.5
B1DN86	1-Nov	Pump	N/A	370	140	393	392.5	0.5
B1DN38	2-Nov	Kabis	398	N/A	145	398	398	0
B1DN39	3-Nov	Pump	N/A	379	150	403	402	1
B1DN40	3-Nov	Kabis	408	N/A	155	408	408	0
B1FRY1	7-Nov	Pump	N/A	389	160	414	412.5	1.5
B1DN54	7-Nov	Pump	N/A	389	160	414	412.5	1.5
B1DN65	7-Nov	Pump	N/A	389	160	414	412.5	1.5
B1DN76	7-Nov	Pump	N/A	389	160	414	412.5	1.5
B1DN87	7-Nov	Pump	N/A	389	160	414	412.5	1.5
B1DN42	8-Nov	Kabis	418	N/A	165	418	418	0
B1DN43	9-Nov	Pump	N/A	400	170	423	417.5	5.5
B1FTR4	9-Nov	Kabis	428	N/A	175	428	428	0
B1FV68	10-Nov	Pump	N/A	400	180	433	426	7
B1FTV4	10-Nov	Pump	N/A	400	180	433	426	7
B1FTW4	10-Nov	Pump	N/A	400	180	433	426	7
B1FTX4	10-Nov	Pump	N/A	400	180	433	426	7
B1FTY4	10-Nov	Pump	N/A	400	180	433	426	7
B1FTR5	11-Nov	Kabis	438	N/A	185	438	436	2
B1FV05	11-Nov	Kabis	438	N/A	185	438	436	2

Notes:

bgs = below ground surface

bwt = below water table

ft = feet

Sep = September

Oct = October

Nov = November

N/A = not applicable

ND = no data

Kabis = Kabis discrete point-interval groundwater sampler

2.2.3 Well Completion Summary

Well construction materials, filter pack installation, initial well development, and annular seal for well 299-W11-45 (C4948) are discussed below. A straightness test was performed using an 8 5/8-inch OD, 20.9 ft long tool prior to well completion activities. Construction and completion of this well was carried out from November 21, 2005 to March 9, 2006. Well completion summary data are provided in Table 2-2 and well construction summary sheets are presented in Appendix C.

- **Screen, Riser Casing, and Filter Pack.** 6-inch ID, Schedule 10S, Type 304L stainless steel screen and riser materials were chosen for this well, consisting of 283.28 feet of permanent well casing, a 14.59 foot 20-slot (0.020-in) continuous v-wire wrap screen and a 3.00 foot sump. Filter pack material consists of 10-20 mesh filter pack sand. These selections were based on hydrogeology encountered during drilling, as well as information from nearby wells. The bottom of the stainless steel sump was placed at 298.87 feet bgs and the bottom of the stainless steel screen was set at 295.87 feet bgs while the top of the screen was set at 281.28 feet bgs. The top of the stainless steel riser casing was set 2.0 feet above ground surface. The annular space between the stainless steel casing and the sediments in the borehole was filled with 10-20 mesh filter pack sand from 426.5 feet bgs to 308.1 feet bgs and 303 ft bgs to 271.9 ft bgs, as well as 266 ft bgs to 243.8 ft bgs. An approximate 5-foot bentonite pellet seal separated each of the filter pack intervals. The filter pack is approximately 10 ft above the top of the screen and 10 ft above the current static water level.
- **Filter Pack Installation and Initial Well Development.** The filter pack installation and initial well development process consisted of introducing silica sand into the annular space around the screen and settling the filter pack to eliminate void spaces. Development of the well removed fines in the newly constructed well and reconditioned the borehole walls to minimize effects of drilling, primarily due to caving. A dual-flange surge block was used to develop and settle the sand filter pack in the annular space between the screen and the borehole walls. Surging was carried out in 8 stages, developing the screen in 2 ft interval (approximately 296 feet bgs to 280 feet bgs). Overlap between the filter sand and temporary casing was maintained throughout so that unconsolidated formation sediments would not cave and come in direct contact with the well screen. The level of the filter pack was measured periodically with a weighted tape to monitor overlap and determine when the settling rate within the filter pack had decreased to less than 0.1 feet over a period of 15 minutes. The sand filter pack was surged for combined total of 445 minutes before stability was achieved.
- **Annular Seal.** An annular seal was constructed above and below the filter pack using 3/8-inch coated bentonite pellets, extending from 436.9 ft bgs to 426.5 ft bgs, 308.1 to 303 ft bgs, 271.9 to 266 ft bgs, and 243.8 to 238.2 ft bgs. Bentonite crumbles were placed inside the borehole from 238.2 ft bgs to 11.45 ft bgs and a grout seal was installed from 11.45 feet bgs to ground surface, consisting of Portland Type I/II cement and 5% bentonite powder by volume per WAC 173-160.

2.2.4 Final Well Development Summary

Final well development for 299-W11-45 (C4948), was performed in accordance with FH procedure GRP-EE-01-6.3, "*Well Development and Testing*" on March 8th and 9th of 2006. A 3-HP Grundfos electric submersible pump was used to develop the well in a one stage interval until turbidity was less than 5 Nephelometric Turbidity Units (NTU) and other water parameters including temperature and conductivity had stabilized. Water level drawdown during development was monitored continuously using a 20 psi pressure transducer and was recorded with an In-Situ Hermit 3000 datalogger. During development, the pump was operated with the intake located 291 ft from the top of the permanent protective casing (TOC) or 288 ft bgs. The flow rate was maintained at approximately 13 gpm for 8 minutes, 17.6 gpm for 205 minutes and 6.6 gpm for 147 minutes until the turbidity value reached 4.33 NTU. Drawdown observed while the flow rate was at 13 gpm averaged at 22.55 ft, while the flow rate was 17.6 gpm, drawdown averaged out at 23.72 ft and while the flow rate was 6.6 gpm, drawdown averaged at 7.84 ft. Final groundwater parameters are presented in Table 2-3 and well development data are found in Appendix D. Drawdown and recovery curves for the final well development of well 299-W11-45 (C4948) are also presented in Appendix D.

2.1.1e Sampling Pump Installation Summary

Pump installation was completed on March 10, 2006. A 1.5-horsepower (HP), 8-stage, electric submersible pump (Grundfos™ Model- A P1-0527 10SQE340NE) was installed with the pump intake set at 286 ft TOC (283 ft bgs), which is 1.72 feet below the top of the screen and approximately 29.5 feet below the static water table).

™ Grundfos is a trademark of Grundfos Pumps Corporation of Clovis, California.

Table 2-2. Well Completion Summary for Well 299-W11-45 (C4948).

Well Name	Well ID	Operable Unit (OU)	Water Level (ft bgs)	Screen[a]					Sandpack[b] Interval (ft bgs)	Seal[c] (ft bgs)	Grout[d] Depth (ft bgs)	Riser		Pump Intake Depth[e] (ft bwt)
				Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Screen Length (ft)	Sump (ft)	Material				Top (ft)	Material	
299-W11-45	C4948	ZP-1	253.5	281.28	295.87	14.59	3.00	ss304L	243.8 - 266 271.9 – 303 308.1 – 426.5	238.2 – 243.8 266 – 271.9 303 – 308.1 426.5 - 438	0.0 – 11.45	+2.0	ss304L	~29.5

Notes:

[a]Screen slot size is 0.020 inch.

[b]Sandpack consists of Colorado silica sand (10-20 mesh).

[c]Bentonite seal consists of 3/8-inch bentonite pellets.

[d]Grout consists of Portland Type I/II cement.

[e] Pump intake depth is determined from groundwater readings taken on day pump was installed and piping used in pump installation. Water level readings recorded at pump installation may vary somewhat from data collected during drilling (column 4).

bgs = below ground surface

bwt = below water table

ft = feet

N/A = not applicable

OU = operable unit

ss = stainless steel

~ = approximate value given

Table 2-3. Well Development Data for Well 299-W11-45.

Well Name	Well ID	Operable Unit (OU)	Static Water Level (ft bgs)	Development Date(s)	Pump Intake Depth (ft TOC)	Development Pumping Duration (minutes)	Final Turbidity (NTU)	Final Conductivity (µS/cm)	Final Temp (°C)	Final Flow Rate (gpm)	Final Drawdown (ft)	Total Gallons Pumped
299-W11-45	C4948	ZP-1	253.5	3/8/06 – 3/9/06	291	494	4.33	1564	12.3	6.6	7.84	6,400

Notes:

TOC = top of casing

gpm = gallon per minute

ft = feet

NTU = Nephelometric Turbidity Units

µs/cm = micro seimen per centimeter

^{0}C = degrees Centigrade

3.0 WASTE MANAGEMENT

The ZP-1 OU has specific requirements regarding waste generation as outlined in the supporting documentation. Waste generated from the installation of the well was handled according to the *Data Quality Objective (DQO) Summary Report for the Installation of One Groundwater Monitoring Well West* [East] *of WMA-T*, WMP-26959 (FH 2005), with additional details provided below.

3.1 ZP-1 OPERABLE UNIT

Cutting spoils for the ZP-1 OU were handled as described in the following sections.

3.1.1 Vadose Zone Cuttings

Vadose zone cuttings from ZP-1 OU groundwater monitoring well (C4948) were designated low risk from chemical or radiological contamination and were collected in stockpiles near the point of generation until released back into the ground based on field surveys by radiological control technicians (RCT). Drill cuttings were surveyed in accordance with *Hanford Site Solid Waste Acceptance Criteria* (HNF-EP-0063). Vadose zone cuttings were returned to the environment prior to the final well acceptance walkdown.

All wastes generated from drilling and sampling operations were handled as CERCLA waste and were managed in accordance with the *DQO Summary Report for the Installation of One Groundwater Monitoring Well West* [East] *of WMA-T*, WMP-26959 (FH 2005).

3.1.2 Saturated Zone Cuttings

All drill cuttings below the highest recorded water table (approximately 202 feet bgs) were containerized in 55-gallon drums lined with a 10-mil plastic liner. Drums were stored on site for final disposition.

3.1.3 Purgewater

Purgewater was collected and contained at the well until transported to the Purgewater Storage and Treatment Facility or the Effluent Treatment Facility. Purgewater, groundwater samples, and decontamination fluids generated during well drilling and sample screening were managed as purgewater in accordance with FH procedure GRP-EE-01-1.11, "*Purge Water Management*", and 90-ERB-040, *Strategy for Handling and Disposing of Purgewater at the Hanford Site, Washington* (Izatt 1990).

4.0 GEOPHYSICAL SURVEY

Borehole geophysical surveys were performed in well 299-W11-45 (C4948) on September 16 and 19, 2005 and November 17 and 18, 2005. Spectral Gamma Logging System (SGLS) surveys were carried out by S.M. Stoller Corporation from ground surface (0 feet) to 427 feet bgs. Results of the SGLS indicate that Cs^{137} was the only man-made radionuclide within the borehole, though it was detected at its minimum detection limit (MDL) of 0.4 pCi/g at sporadic locations. It is S.M. Stoller's interpretation that these detections are merely statistical fluctuations and should not be considered valid. A separate report will provide specific details of these geophysical surveys.

5.0 CIVIL SURVEY

The civil survey of well 299-W11-45 (C4948) was performed on April 4, 2006 by a Fluor Federal Services (FFS) Land Surveyor using a Global Positioning System (GPS) under the NAD83 (91) datum. Well 299-W11-45 (C4948) is located at 136775.64 meters North, 566992.84 meters East. Elevation was measured using a leveling technique, from the top of the brass survey marker placed within the surface monument at the time of well completion, under NAVD88 datum. The elevation for the well is 213.614 meters. The civil survey data is available in the Hanford Well Information System (HWIS) database.

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6.0 WELL ACCEPTANCE

The ZP-1 groundwater monitoring well, 299-W11-45 (C4948), was transferred from Blue Star Enterprises and accepted by FH. A site acceptance walk down for the well was performed on March 14, 2006 and included representatives from Blue Star Enterprises, GRAM, Inc., and FH, including FH representatives from Geosciences, Environmental Compliance and Quality Assurance (QA).

QA surveillance was performed during the final acceptance walk down. Aspects of well drilling such as functionality of the well, selection of well construction materials, surface protection features, sampling pumps, well identification and site clean-up were observed. The surveillance was deemed satisfactory.

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7.0 SUBSURFACE DESCRIPTION

7.1 ZP-1 OPERABLE UNIT

This section provides the generalized stratigraphy in the ZP-1 OU, as well as summaries of field observations

7.1.1 Geology/hydrogeology

Generalized stratigraphy in the ZP-1 OU of the Hanford Site includes surficial sediments that primarily consist of Holocene aeolian sands and silts, generally less than 5 m in thickness. The aeolian sediments overlie unconsolidated sediments of the Hanford formation, consisting of sandy gravels and gravelly sands with minor interbedded silt and sand layers. The Hanford formation overlies unconsolidated silts and sands of the Cold Creek Unit, consisting of carbonate-rich silt and sand, interfingered with carbonate-poor silt and sand and occasional caliche. The Cold Creek Unit disconformably overlies sands and gravels of Unit E of the Ringold Formation. Ringold Formation Unit E sediments conformably overly the Ringold Lower Mud (RLM), an overbank flood deposit that consists primarily of a sandy to clayey silt with minor sand lenses. The RLM conformably overlies coarse basaltic gravels of Unit A of the Ringold Formation. Ringold Formation Unit A sediment disconformably overlies basalt of the Columbia River Basalt Group.

7.1.2 Well 299-W11-45 (C4948)

At this location, in-situ sediments are overlain by a backfill layer of intermixed aeolian sands and crushed gravels, which extend from ground surface to a depth of about 0.2 ft bgs. Sediment below the gravel fill, from 0.2 – 2 feet bgs consists of aeolian sand and silt. The interval from 2 - 24 feet bgs contains a gravel-dominated facies belonging to the Hanford formation. The gravel dominated facies consists of mafic-rich sandy gravels and silty sandy gravels. These sediment consist primarily of poorly-sorted, well-rounded pebbles and cobbles up to 6 inches (15 cm) in diameter with very fine- to coarse-grained sand and silt.

Sand-dominated fluvial deposits of the Hanford formation were encountered from 24 – 98 ft bgs. These deposits consist of medium to very coarse heterolithic sands and interbedded gravelly sands consisting of medium- to very coarse-sand and less than 30% fine- to medium-grained mafic-dominated pebbles.

The Hanford formation overlies sediments of the Cold Creek Unit, encountered in the borehole from 98 ft bgs to 138 ft bgs. The upper portion of the Cold Creek Unit, between 98 ft bgs and 110 ft bgs consists of very-well sorted carbonate-rich silts and calcium carbonate-cemented gravelly sands (caliche). The lower portion of the Cold Creek Unit, between 110 ft bgs and 138 ft bgs consists of carbonate-rich silty sands with intermittent caliche nodules, gravelly sands with less than 15% mafic-rich pebbles, and caliche-encrusted massive silt layers that contain less than 10% sand.

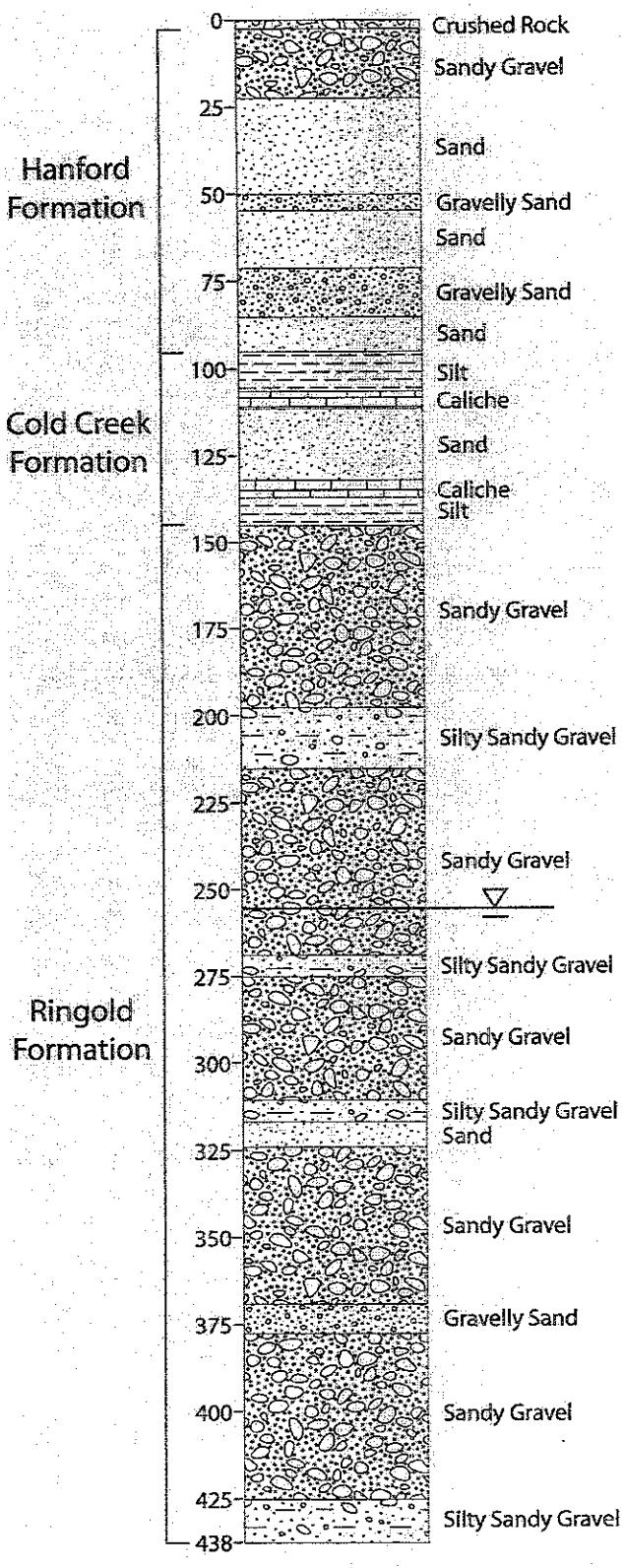
The Ringold Formation, Unit E was encountered between 138 ft bgs to 433 ft bgs. At this location, the Ringold Unit E consists of gravelly sands, sandy gravels and silty sandy gravels.

Pebbles and cobbles in this interval are 30 to 60% mafic-rich and the remainder of the sediments consist of felsic, volcanic, metamorphic and granitoid cobbles; presumably derived from volcanic terranes, unroofed intrusives, and metamorphic terranes in the Cascade Mountain range. Sands in this interval are fine to medium grained; approximately 15 to 40% of the total volume is quartz-dominated. Silt fractions range between 5 and 20%. Within the lower section of this interval (425 ft bgs to 433 ft bgs) sparse clay nodules were observed in the borehole cuttings and could represent a very thin layer of the Ringold Lower Mud unit.

Sediments of the Ringold Formation Unit A were encountered between 433 ft bgs to 438 ft bgs (TD). The Ringold Unit A in this interval consists of silty sandy gravels that are mafic-rich and felsic-poor. A silty-sandy matrix is found in the silty sandy gravels within the interval, and displays very dark gray-green staining and as well as dark colored lenses of silt interbedded with cobbles of weathered basalt.

Lithologic descriptions and geologic borehole logs for this well were prepared in accordance with FH procedure GRP-EE-01-7.0, "*Geologic Logging*," and are included in Appendix B.

Figure 7-1 Subsurface Geology of Well 299-W11-45 (C4948)



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APPENDIX A:

WELL SUMMARY SHEET

WELL C4948 (3 PAGES)

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WELL SUMMARY SHEET

Start Date: 9-2-05
Finish Date: 3-9-06
Page 1 of 3

Well ID: C4948	Well Name: 299-W11-45
Location: East of WMA-T 200W	Project: T-2 Monitoring Well
Prepared By: Jake Horner Date: 3-8-06	Reviewed By: L.D. Walker Date: 3/29/06
Signature: Jake Horner	Signature: L D Walker

CONSTRUCTION DATA

Description	Diagram
6" Stainless steel Sch 10 Type 304L riser pipe: +2.0' – 281.28' bgs	
6" Stainless steel Sch 10 Type 304L 20 slot screen: 281.28' – 295.87' bgs	
6" Stainless steel Sch 10 Type 304L Sump: 295.87' – 298.87' bgs	
Cement Grout: 0' – 11.45' bgs	
Granular Bentonite: 11.45' – 238.2' bgs	
Protective surface casing is 8" SS set 1.0' above the 6" riser	
13 3/8" Temp. casing: 0' – 196.5' bgs	
10 3/4" Temp. casing: 196.5' – 436.2' bgs	
All temporary casing was removed.	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
0		0'-0.2': Crushed rock
		0.2'-2': Sandy Silt (≈M)
		2'-5': Silty Sandy Gravel (sG)
		5'-10': Sandy Gravel (sG)
		10'-18': Silty Sandy Gravel (sG)
		18'-24': Sandy Gravel (sG)
25		
		24'-50': Sand (S)
50		50'-54': Gravelly Sand (gS)
		54'-63': Sand (S)
		63'-65.5': Gravelly Sand (gS)
		65.5'-73': Sand (S)
75		
		73'-89.5': Gravelly Sand (gS)
		89.5'-98': Sand (S)
100		
		98'-107': Silt (M)
		107'-110': Caliche
		110'-131.5': Sand (S)
125		
		131.5'-132': Caliche
		132'-138': Silt (M)
		138'-195': Sandy Gravel (sG)

A-6003-643 (03/03)

WELL SUMMARY SHEET

Start Date: 9-2-05
Finish Date: 3-9-06
Page 2 of 3

Well ID: C4948
Well Name: 299-W11-45
Location: East of WMA-T 200W
Project: T-2 Monitoring Well
Prepared By: Jake Horner Date: 3-8-06
Reviewed By: L.D. Walker Date: 3/29/06
Signature: Jake Horner
Signature: L.D. Walker

CONSTRUCTION DATA

Description	Diagram
Bentonite pellets: 238.2' – 243.8' bgs	
10-20 mesh silica sand: 243.8' – 266 bgs	
Bentonite pellets: 266' – 271.9' bgs	
10-20 mesh silica sand: 271.9' – 303' bgs	
Groundwater depth: 253.5' bgs (3-9-06)	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
150		138'-195': Sandy Gravel (sG)
175		
200		195'-220': Silty Sandy Gravel (msG)
225		220'-250': Sandy Gravel (sG)
250		250'-252': Silty Sandy Gravel (msG)
		252'-270': Sandy Gravel (sG)
		270'-275': Silty Sandy Gravel (msG)
275		275'-315': Sandy Gravel (sG)

A-6003-643 (03/03)

WELL SUMMARY SHEET

Start Date: 9-2-05
Finish Date: 3-9-06
Page 3 of 3

Well ID: C4948
Well Name: 299-W11-45
Location: East of 200W
Project: T-2 Monitoring Well
Prepared By: Jake Horner
Date: 3-9-06
Reviewed By: L.D. Walker
Date: 3/29/06
Signature: Jake Horner
Signature: L.D. Walker

CONSTRUCTION DATA

Description	Diagram
Bentonite Pellets: 308.1' - 303.0'	
10-20 mesh silica sand: 436.5' - 308.1'	
Bentonite Pellets: 436.9' - 426.5'	
Natural Backfill: 438.0' - 436.9'	
All depths are in ft. below ground surface.	
All temporary casing was removed.	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
300		275'-315': Sandy Gravel (sG)
		315'-318': Silty Sandy Gravel (msG)
325		318'-322': Sand (S)
		322'-370': Sandy Gravel (sG)
350		
375		370'-378': Gravelly Sand (gS)
400		378'-425': Sandy Gravel (sG)
425		425'-438': Silty Sandy Gravel (msG)
		TD = 438 ft bgs

A-6003-643 (03/03)

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APPENDIX B

BOREHOLE LOG

WELL C4948 (11 PAGES)

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BOREHOLE LOG

Page 1 of 11
Date: 9-2-05

Well ID: C4948 | Well Name: 299-W11-45 | Location: ~300' East of WMA-T
Project: T-2 Groundwater Monitoring well | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0-0.2' Crushed rock (drill pad)	Cable tool with temporary carbon steel casing & drive head
				0.2'-2' Sandy silt (sM)	
5	Grab			2'-5' Silty sandy gravel (msG) v. coarse pebbles to small cobbles with med-fine sand & silt.	5' Archive Sample (A.S.) #1
10	Grab			5'-10' Sandy gravel (sG) Well-rounded, med-v. coarse pebbles with med-coarse sand & ≤10% silt.	10' A.S. #2
15	Grab			10'-18' Silty sandy gravel (msG) Sub-rounded pebble-cobble gravel with coarse to fine sand & ~15% silt.	15' A.S. #3
20	Grab			18'-24' Sandy gravel (sG) V.P. sorted - sub-rounded pebbles & cobbles (70% basalt, 30% other) with coarse sub-angular sand (60-70% basalt).	20' A.S. #4A & 4B
25	Grab			24'-40' Sand (S) Well-sorted sub-angular, med. grained heterolithic sand with <10% pebbles - @ ~35' bgs a 2" layer of sandy silt was encountered.	25' A.S. #5A & 5B
30	Grab				30' A.S. #6A & 6B
35	Grab				35' A.S. #7A & 7B

Reported By: Jake Horner
Title: Geologist
Signature: Jake Horner Date: 9-2-05

Reviewed By: L.D. Walker
Title: Geologist
Signature: L.D. Walker Date: 12/27/05

BOREHOLE LOG

Page 2 of 11
Date: Start 9-2-05 Finish 9-6-05

Well ID: C4948 | Well Name: 299-W11-45 | Location: ~300' East of WMA-T
Project: T-2 GW Monitoring Well | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	Grab			44'-50' Sand (S) Moderately sorted, course, sub-angular lithodithic sand with sparse fine pebbles	40' A.S. # 8A & 8B
45	Grab			50'-54' Gravelly sand (gS) Mod. sorted, med.-course sub-angular sand with fine to med. pebbles (75% s, 25% g).	45' A.S. # 9A & 9B
50	Grab			54'-56' Sand (S) Mod. sorted, med. grained, sub-angular sand (lithodithic) with weak carbonaceous cement (reacts w/ HCl).	50' A.S. # 10A & 10B
55	Grab			56'-63' Sand (S) Same as above, with no cement	55' A.S. # 11A & 11B
60	Grab			63'-65.5' Gravelly sand (gS) Poorly sorted, fine-course, sub angular lithodithic sand with fine, sub-angular to sub-rounded pebbles (70% basalt, 30% other). Many sand grains display minor oxidation & are weakly cemented.	60' A.S. # 12A & 12B
65	Grab			65.5'-73' Sand (S) Well-sorted, course, sub-angular to sub-rounded lithodithic sand with sparse pebbles.	65' A.S. # 13A & 13B
70	Grab			73'-78' Gravelly sand (gS) Well sorted, v. coarse, sub-angular to angular lithodithic sand with v. fine to med. sub-angular pebbles (80% basalt, 20% other). Pebbles & sand are slightly oxidized.	70' A.S. # 14A & 14B
75	Grab				75' A.S. # 15A & 15B

Reported By: Jake Horner | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: Jake Horner | Date: 9-6-05 | Signature: L.D. Walker | Date: 12/27/05

A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 11
Date: 9-6-05 to 9-8-05

Well ID: C4948 | Well Name: 299-W11-45 | Location: ~300' East of WMA-T
Project: T-2 GW Monitoring Well | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
80	Grab			78'-88.5' Gravelly sand (gS) Pebbles became smaller (v. fine-fine) & are more coarse. ~5% silt is also present.	80' A.S. #16A & 16B
85	Grab			@85' Gravelly sand (gS) well-sorted, v. coarse sub-rounded sand (40% Qtz, 60% other) & fine-med. sub-rounded pebbles (70% basalt, 30% other). Minor CaCO3 is present, forming v. weak clumps of sand.	85' A.S. #17A & 17B
90	Grab			89.5'-89.7' Silt (M) Olive brown (2.5Y 4/3) layer of moist silt.	90' A.S. #18A & 18B
95	Grab			89.7'-96' Sand (S) Mod. sorted, med. to v. coarse sub-rounded to sub-angular sand with coarse, sub-rounded v. fine basalt pebbles. Very similar to gS above the silt, but with fewer pebbles. V. coarse sand grains are 70% basalt.	95' A.S. #19A & 19B
100	Grab			-@97' grain size decreases to a medium grained sand with very few v. fine pebbles. Very weak CaCO3 cementation is encountered, forming small clumps of sand.	100' A.S. #20A & 20B
105	Grab				105' A.S. #21A & 21B
110	Grab			98'-107' Silt M v. well sorted, moderately cemented (with CaCO3) silt	107' A.S. #22A & 22B 110' A.S. #23A & 23B
115	Grab			107'-~110' CaCO3 cemented sand & gravel (caliche).	115' A.S. #24A & 24B

Reported By: Jake Hamer | Title: Geologist | Signature: Jake Hamer | Date: 9-8-05
Reviewed By: L.D. Walker | Title: Geologist | Signature: L.D. Walker | Date: 12/27/05

A-6003-642 (03/03)

BOREHOLE LOG

Page 4 of 11
Date: 9-8-05 to 9-12-05

Well ID: C4948 | Well Name: 299-W11-45 | Location: ~300' East of WMA-T
Project: T-2 GW Monitoring Well | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
120	Grab			110'-111' Silty sand (m S) weakly cemented, poorly sorted silty sand with small caliche nodules	120' A.S. #25A & 25B
				111-112 Sandy silt (sM) very pale brown (10YR 7/3, moist) $CaCO_3$ has decreased	
125	Grab			112'-113' Slightly silty sand (m S) mod sorted, fine-grained, sub-angular to sub-rounded sand	
130	Grab			with 15% silt. Pebbles are very sparse. Silt is light tan & reacts with HCl.	130' A.S. #27 & 28B
				113'-117' Sand (S) well sorted, med-fine, sub-angular hydrolithic sand.	
135	Grab				135' A.S. #28A & 28B
					*Changed to hard tool drilling method @ 138' bgs.
140	Grab			117'-121' Silty sand (m S) Fine grained sand with ~30% silt & 10-20% v. coarse basalt sand grains. $CaCO_3$ laminations are present	140' A.S. #29A & 29B
145	Grab			121'-127' Silty sand (m S) same as above, but with increase cementation & caliche nodules are present.	145' A.S. #30A & 30B
150	Grab			127'-130' Sand (S) Mod. sorted, coarse to fine sand with ~10% silt. Larger sand grains are mostly basalt. Weak $CaCO_3$ cem. is still present	150' A.S. #31A & 31B
155	Grab			130'-131.5' Gravelly sand (g S) 90% mod. sorted, coarse, sub-angular sand (50% basalt) & 10% poorly sorted, sub-round pebbles (80% basalt).	155' A.S. #32A & 32B

Reported By: Jake Horner | Title: Geologist | Signature: Jake Horner | Date: 9-12-05

Reviewed By: L.D. Walker | Title: Geologist | Signature: L.D. Walker | Date: 12/27/05

A-6003-642 (03/03)

BOREHOLE LOG

Page 5 of 11

Date: 9-12-05 to 9-20-05

Well ID: C4948	Well Name: 299-W11-45
Location: ~300' East of WMA-T	
Project: T-2 GW Monitoring Well	Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
160	Grab			131.5'-132' Caliche layer white (10YR 8/1, dry) mod. cemented sand & silt.	160' A.S. #33A & 33B
					Cable tool, hard tool drilling
				132'-138' Silt (M) / Sandy silt (sM) v. well sorted light olive brown	
165	Grab			(2.5Y 5/3, slightly damp) with mand 10% very fine sand -@136' silt is very wet, forming a small pocket of mud. Silt is barely damp above &	165' A.S. #34A #34B
170	Grab			below 136' bgs.	170' A.S. #35A & 35B
				138'-195' Sandy gravel (sG) mod sorted, well-rounded to	
175	Grab			sub-rounded small cobbles & coarse pebbles with ~15% mod. to fine sand & 5% silt. Cobbles & pebbles are predominantly quartzite. Gravels are mod. cemented	175' A.S. #36A & 36B
180	Grab			@165' bgs cobbles & pebbles are predominantly basalt (~60%) with ~20% quartzite. sand fraction is quartz dominated with ~70% quartz & 30% mafic.	180' A.S. #37A & 37B
185	Grab			Silt fraction ranges from 2 to 5%.	185' A.S. #38A & 38B
				195'-220' Silty sandy gravel (msG) Sub-rounded pebbles & cobbles	
190	Grab			(predominantly quartzite) with 35% mod. to fine sand (65% quartz) & >10% silt. Silt fraction was determined by an increased thickness in hard tool cuttings.	190' A.S. #39A & 39B
195	Grab				195' A.S. #40A & 40B

Reported By: John Horner	Reviewed By: L.D. Walker	
Title: Geologist	Title: Geologist	
Signature: [signature] Date: 9-20-05	Signature: [signature]	Date: 12/27/05

A-6003-642 (03/03)

BOREHOLE LOG — Page 6 of 11 — Date: 9-20-05 to 9-21-05

Well ID: C4948 — Well Name: 299-W11-45 — Location: ~300' East of WMA-T

Project: T-2 GW Monitoring Well — Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
200	Grab			220'-250' Sandy gravel sub-rounded pebbles & cobbles (60% quartzite) with med. sand (60-70% quartz) & <10% silt. Pebbles & cobbles are weakly to moderately cem. with no reaction to HCl.	200' A.S. #41 & 41B
205	Grab				205' A.S. #42A & 42B
210	Grab			250'-252' Silty sandy gravel. Mod. sorted, sub-rounded, heterolithic fine pebbles to large cobbles (quartzite, metased., basalt & granite) with sub-rounded to sub-angular medium grained sand (30-60% quartz) & ≥20% silt. The sandy silt matrix is a dark grayish brown 2.5Y4/2 (damp).	210' A.S. #43A & 43B
215	Grab				215 A.S. #44A & 44B
220	Grab			@251' the soil becomes more damp	220' A.S. #45A & 45B
225	Grab				225' A.S. #46A & 46B
230	Grab				230' A.S. #47A & 47B
235	Grab				235' A.S. #48A & 48B

Reported By: Jake Horner — Title: Geologist — Signature: Jake Horner — Date: 9-21-05

Reviewed By: L.D. Walker — Title: Geologist — Signature: LD Walker — Date: 12/27/05

A-6003-642 (03/03)

BOREHOLE LOG

Page 7 of 11

Date: 9-21-05 to 10-6-05

Well ID: C4948	Well Name: 299-W11-45	Location: ~300' East of WMA-T
Project: T-2 GW monitoring well		Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
240	Grab			252'-270' Sandy gravel (sG)	
				Mod. sorted sub-rounded to	240' A.S. #49A & 49B
				well rounded basaltic pebbles	
				& cobbles (60% quartzite) with	
				sub-angular to sub-rounded	
245	Grab			med. to fine sand (60% quartz)	245' A.S. #50A & 50B
				& ≤10% silt. Silt fraction is	@247' changed back
				concentrated on cobble surfaces.	to drive barrel method.
				Gravels are mod. cemented.	Water Table = 253.2' bgs
250	Grab			@ 265' silt fraction has	
				noticeably reduced.	250' A.S. #51A & 51B
255	Grab				255' A.S. #52A & 52B
					259' bgs Kabis sample #s
	W.S.				BIDW10
260	Grab				260' A.S. #53A & 53B
					263' bgs Bailed sample #s
	W.S.				BIDWX8
					BIDWY0 (PVHL)
265	Grab				BIDWY2
					BIDWY4
					265' AS #54A & 54B
	W.S.			270'-275' Silty sandy gravel	268' bgs Kabis sample #s
				Mod. cemented, well-rounded to	BIDW08 & BIDW12 (PVHL)
270	Grab			sub rounded, poorly sorted	270' A.S. #55A & 55B
				basaltic pebbles & cobbles	274' Bailed sample #s
				with fine to coarse sand	BIDW13, BIDW56,
				& ~20% silt. No reaction	BIDW45 BIDW67 & BIDW78
	W.S.			to HCl	(PVHL)
275	Grab				~~275~~ 10-6-05
					275' A.S. #56
					279' pumped sample #s
	W.S.				BIDW03, BIDW04
					BIDW05 & BIDW06

Reported By: John Horner		Reviewed By: L.D. Walker	
Title: Geologist		Title: Geologist	
Signature: John Horner	Date: 10-6-05	Signature: LD Walker	Date: 12/27/05

A-6002-647 (03/03)

BOREHOLE LOG

Page 8 of 11
Date: 10-6-05 to 10-18-05

Well ID: C4948 | Well Name: 299-W11-45 | Location: ~300' East of WMA-T

Project: T-2 GW Monitoring Well | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	W.S.			275' – ~~280'~~ 318' Sandy gravel (SG)	279' w.s.# BIDN03,
280	Grab			Poorly sorted, sub-rounded to	BIDN04, BIDN05
				well-rounded pebbles &	& BIDN06.
	W.S.			cobbles with well-sorted,	278' Kabis samples
				sub-angular to sub-rounded,	BIDN11 & BIDN14
285	Grab			med. to fine silica sand (40%)	
				& <10% silt. Silt is conc.	A.S. #57 @ 280'
	W.S.			in pockets on weathered cobble	A.S. #58 @ 285'
				surfaces. Sand fraction is	
				generally clean, with <2% silt	290' A.S. #59
290	Grab			gravels are moderately cemented.	
				Maximum cobble is ~15cm	283.6' PNNL w.s. #s
					BIDN46, BIDN57, BIDN68
	W.S.			283' sand fraction is dominantly	BIDN79, BIDWX9, BIDWY1
				quartz (~70%).	BIDWY3 & BIDWY5
295 300	Grab				295' A.S.# 60
				310' increasing silt content	288' Kabis sample #s
					BIDN16
	W.S.			315' – 318' Silty sandy gravel	293' Kabis # BIDN17
				Mod. sorted, well to sub-	293' Pumped # BIDN47,
295 300	Grab			rounded pebbles & cobbles	BIDN57, BIDN69 &
				with poorly sorted, fine to	BIDN80
				coarse sand & ~15% silt.	300' A.S. # 61
	W.S.				298' Kabis # BIDN18
					& BIDN19
305 310	Grab				302.7' Pumped sample #
					BIDN48, BIDN59,
					BIDN70, & BIDN81
					305' A.S. # 62
					308.6' Kabis # BIDN20
310 315					310' A.S. #63
				318' – 322' Sand (S)	314' Kabis # BIDN21
				Mod-well sorted ~~coarse~~ sub-	314' Pumped # BIDN49,
				rounded, med. silica sand	BIDN60, BIDN71 &
				(20% mafic) with very sparse	BIDN82 (PNNL) &
315 320				pebbles & no silt.	FH samples BIFK2, BIFK3
					& BIFK4.
				@ 319.5' pebble/cobble fraction	315' A.S. # 64
				increases (15% pebbles	318' A.S. #65
				& cobbles, 85% silica sand)	

Reported By: Jake Horner | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: [signature] | Date: 10-18-05 | Signature: [signature] | Date: 12/27/05

A-6003-642 (03/03)

BOREHOLE LOG

Page 9 of 11
Date: 10-18-05 to 10-26-05

Well ID: C4948 | Well Name: 299-N11-45 | Location: East of WMA-T (~300')
Project: T-2 GW Monitoring Well | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
320	Grab			322'-327' Sandy gravel (sG) Pebble/cobble fraction increased to 50%, max cobble is ~5", mica silt is now present. Sand fraction is mod to fine with 65% qtz & 35% mafics	318.6' Kabis #
	W.S.				BIDN15 & BIDN21
					320' A.S. # 66
					323' Pumped # BIDN23
325	Grab				325' A.S. # 67
	W.S.			@ 325' a 4" layer of well-sorted, med. grained silica sand with few pebbles was encountered	328' Kabis # BIDN25 (24)
					330' A.S. # 68
330	Grab				333' Pumped # BIDN50, BIDN66, BIDN72 & BIDN83 (Rinse) & FH Sample #s BIECX0, BIECX1 & BIECX2
	W.S.			327'-330' Sandy gravel (sG) 65% poorly sorted, sub-angular to sub-rounded pebbles & cobbles (max cobbles are ~5") with 30% sub-angular, med. grained silica sand & 5% silt accumulated on cobble surfaces.	
335	Grab				335' A.S. # 69
	W.S.				338' Kabis # BIDN26
					340' A.S. # 70
					343' Pumped # BIDN27
340	Grab				343' change to hard tool drilling method
					345' A.S. # 71
	W.S.				348' Kabis # BIDN28
					350' A.S. # 72
					352.5' Pumped Rinse samples: BIDN51, BIDN62, BIDN73 & BIDN84 & FH samples:
345	Grab				
	W.S.				355' A.S. # 73
350	Grab			350' same as above	358' Kabis # BIDN30
	W.S.				360' A.S. # 74
					363' Pumped sample # BIDN31
355	Grab				365' A.S. # 75
	W.S.				

Reported By: Jake Horner | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: [signature] Date: 10-24-05 | Signature: [signature] Date: 12/27/05

A-6003-642 (03/03)

BOREHOLE LOG

Page 10 of 11
Date: 10-26-05 to 11-2-05

Well ID: C4948	Well Name: 299-W11-45	Location: ~300' East of WMA - T
Project: T2 GW Monitoring Well		Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
360	Grab			365' Sand & silt fraction have increased (60% sand, 35% pebbles/cobbles & 5% silt)	368' Kabis sample # B1DN32
	W.S.				370' A.S. # 76
365	Grab			370'-378' Gravelly sand (gS) Sand fraction continued to increase (70% sand, 25% gravel & ~5% silt). Pebble cutting one ~1cm. Sand is a medium silica-rich sand.	372.5-373': pumped water samples: B1DN74, B1DN52, B1DN85, B1DN63, B1FRC1, B1FRC2, B1FRC3
370	Grab			375': heaving sand - med → coarse, 5-10% pebbles to 1cm	
	W.S.				375' A.S. # 77
375	Grab			378'-425' Sandy gravel (sG) ~~moderate to poorly sorted,~~ heterolithic pebbles & cobble fragments (70%) with poorly sorted med. to v. coarse heterolithic sand (28%) & ~2% silt.	377' Kabis sample # B1DN34
	W.S.				380' A.S. # 78
380	Grab			@385' pebble/cobble fragments size decreases to ~0.5cm (max size).	383' Pumped sample # B1DN35
	W.S.				385' A.S. # 79
385	Grab				388' Kabis sample # B1DN36
	W.S.				390' A.S. # 80
390	Grab			390' same as above	393' Pumped water samples: B1DN53, B1DN64, B1DN75 & B1DN86 (PNNL) & FH samples: B1FRT8, B1FRV0 & B1FRV1. (11/1/05)
	W.S.				
395	Grab				395' A.S. # 81
	W.S.				398' Kabis sample # B1DN38

Reported By: Jake Horner	Reviewed By: L.D. Walker
Title: Geologist	Title: Geologist
Signature: Jake Horner Date: 11-2-05	Signature: LD Walker Date: 12/27/05

A-6003-642 (03/03)

BOREHOLE LOG

Page 11 of 11
Date: 11-2-05 to 11-11-05

Well ID: C4948 | Well Name: 299-W11-45 | Location: East of WMA-T

Project: T-2 Monitoring Well | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
400	Grab				Pumped w.s. # B1DN39
					@ 433' bgs
					400' A.S. # 82
	w.s.				
405	Grab				405' A.S. # 83
	w.s.			415' - Increasing silt fraction	408' Kabis sample # B1DN40
				(5-10%)	
410	Grab			418' - Ringold E gravel (no mud)	410' A.S. # 84
					414' Pumped w.s. #s
				425'-433' Silty sandy Gravel (msG)	PNNL: B1DN54 B1DN65
				Small pebbles to small cobble	B1DN76 & B1DN87
	w.s.			fragments (60% matrix) with 25%	TH: B1FRY0 & B1FRY1
415				med to coarse heterolithic sand	415' A.S. # 85
				& ~15% silt. Sparse 1cm nodules	
				of clay are present. Nodules are	418' Kabis w.s. # B1DN42
	w.s.			clumped together with sand &	418'-419.5' split spoon
	split spoon	+ Grab		cobble cuttings. Could be a	sample to check lithology
420				thin clay lense above the mud	no analyses or sample #. 11/8/05
				or the top of the Lower Mud unit	[illegible]' A.S. # 86 taken
					from SS shoe.
	w.s.			433'-438' Silty Sandy Gravel (msG)	
				Pebble/cobble fraction has increased	423' Pumped w.s. #
425	Grab			to 70%, some quartzite cobbles	B1DN43
				are still present. Sand/silt matrix	
				consists of two distinct zones.	425' A.S. # 87
	w.s.			Silica sand is present with	428' Kabis w.s. # B1FTR4
				very dark grayish green (2.5/5G	
430	Grab			Gley1) staining & very dark	430' A.S. # 88
				pockets of silt are present plus	435' A.S. # 89 taken from s.s.
				cobbles (weathered basalt?).	[illegible] A.S. # 90 [illegible] 11/10/05
	w.s.				433' Pumped w.s. #s
					TH: B1FV67, B1FV68
435	Grab				B1FV69
	split spoon				PNNL: B1FTV4, B1FTW4,
					B1FTX4 & B1FTY4 &
	w.s.	Grab TD		TD = 438'	B1FTV4
					438' Kabis sample # B1FTR5 & B1FV05

Reported By: Jake Horner	Reviewed By: L.D. Walker
Title: Geologist	Title: Geologist
Signature: Jake Horner Date: 11-11-05	Signature: LD Walker Date: 12/27/05

A-6003-642 (03/03)

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APPENDIX C
WELL CONSTRUCTION SUMMARY FOR:
WELL C4948 (2 PAGES)

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WELL CONSTRUCTION SUMMARY REPORT

Start Date: 9-2-05
Finish Date: 3-9-06
Page 1 of 2

Well ID: C4948 | Well Name: 299-W11-45 | Approximate Location: East of WMA-T 200W
Project: T-2 Monitoring Well | Other Companies: GRAM Inc.
Drilling Company: BSE-NW | Geologist(s): Jake Horner, Mike Carron, Wayman Bowles, Robin Henderson & Jess Hocking
Driller: Gary Howell | License #: 1930

TEMPORARY CASING AND DRILL DEPTH

*Size/Grade/Lbs. Per Ft.	Interval	Shoe O.D./I.D.
13 3/8"	0 - 196.5	13 3/4 / 12 1/8
10 3/4"	196.5 - 436.2	10 3/4 / 9 1/4
	-	
	-	
	-	

*Indicate Welded (W) - Flush Joint (FJ) Coupled (C) & Thread Design
13 3/8" with rope threads
10 3/4" with box threads

DRILLING METHOD / HOLE DIAMETER (in.) / INTERVAL (ft)

Auger:	Diameter 13 3/4 From 0 to 196.5
Cable Tool: ✓	Diameter 10 3/4 From 196.5 to 436.2
Air Rotary:	Diameter ___ From ___ to ___
A.R. w/Sonic:	Diameter ___ From ___ to ___
	Diameter ___ From ___ to ___
	Diameter ___ From ___ to ___
	Diameter ___ From ___ to ___

Drilling Fluid:

Total Drilled Depth: 438' | Hole Dia @ TD: 10 3/4" | Total Amt. Of Water Added During Drilling: ~300 gallons
Well Straightness Test Results: Pass | Static Water Level: 253.5' | Date: 3-9-06

GEOPHYSICAL LOGGING

Sondes (type)	Interval	Date	Sondes (type)	Interval	Date
Spectral Gamma	0 - 427	11-15-05		-	
N/A	-		N/A	-	
	-			-	

COMPLETED WELL

Size/Wt./Material	Depth	Thread	Slot Size	Type	Interval Annular Seal/Filter Pack	Volume	Mesh Size
6 5/8"/6" / SS riser	+2.0 - 281.28	box	n/A	Cement Grout	0 - 11.45	8 ft³	n/A
6 5/8"/6" / SS screen	281.28 - 295.87	box	20	Granular Bentonite	11.45 - 238.2'	567 ft³	n/A
6 5/8"/6" / SS sump	295.87 - 298.87	box	n/A	Bentonite Pellets	238.2 - 243.8	25 ft³	n/A
	-			Silica Sand	243.8 - 266	105 ft³	10-20
	-			Bentonite Pellets	266 - 271.9	1.9 ft³	n/A

OTHER ACTIVITIES

Aquifer Test:	Date:	Well Decommission:	Yes:	No:	Date:
Description:		Description:			

WELL SURVEY DATA (If applicable) Not available at this time

Washington State Plane Coordinates: N/A	Protective Casing Elevation:
	Brass Survey Marker Elevation: - LOW 3/29/06

COMMENTS / REMARKS

See page 2 for more information on well Completion

Reported By:	Title:	Signature:	Date:
Jake Horner	Geologist	Jake Horner	3-24-06

A-6003-658 (04/03)

WELL CONSTRUCTION SUMMARY REPORT

Start Date: 9-2-05
Finish Date: 3-9-06
Page 2 of 2

Well ID: C4948 | Well Name: 299-W11-45 | Approximate Location: East of WMA-T
Project: T-2 Monitoring Well | Other Companies: GRAM Inc.
Drilling Company: BSE-NW | Geologist(s): Jake Horner, Mike Carron, Nathan Bowles, Robin Henderson, Jess Hocking
Driller: Gary Howell | License #:

TEMPORARY CASING AND DRILL DEPTH			DRILLING METHOD	HOLE DIAMETER (In.) / INTERVAL (ft)
*Size/Grade/Lbs. Per Ft.	Interval	Shoe O.D./I.D.	Auger:	Diameter ____ From ____ to ____
	____ - ____		Cable Tool:	Diameter ____ From ____ to ____
	____ - ____		Air Rotary:	Diameter ____ From ____ to ____
	____ - ____		A.R. w/Sonic:	Diameter ____ From ____ to ____
	____ - ____			Diameter ____ From ____ to ____
	____ - ____			Diameter ____ From ____ to ____
*Indicate Welded (W) - Flush Joint (FJ) Coupled (C) & Thread Design				Diameter ____ From ____ to ____

Drilling Fluid:

Total Drilled Depth: | Hole Dia @ TD: | Total Amt. Of Water Added During Drilling:
Well Straightness Test Results: | Static Water Level: | Date:

GEOPHYSICAL LOGGING

Sondes (type)	Interval	Date	Sondes (type)	Interval	Date
	____ - ____			____ - ____	
	____ - ____			____ - ____	
	____ - ____			____ - ____	

COMPLETED WELL

Size/Wt./Material	Depth	Thread	Slot Size	Type	Interval Annular Seal/Filter Pack	Volume	Mesh Size
	____ - ____			Silica Sand	271.9 - 303	160 ft³	10-20
	____ - ____			Bentonite Pellets	303 - 308.1	3.1 ft³	N/A
	____ - ____			Silica Sand	308.1 - 426.5	69.5 ft³	10-20
	____ - ____			Bentonite Pellets	426.5 - 436.9	2.5 ft³	N/A
	____ - ____			Natural Backfill	436.9 - 438	N/A	N/A

OTHER ACTIVITIES

Aquifer Test: | Date: | Well Decommission: | Yes: | No: | Date:
Description: | Description:

WELL SURVEY DATA (If applicable)

Washington State Plane Coordinates: N/A | Protective Casing Elevation: N/A
Brass Survey Marker Elevation:

COMMENTS / REMARKS

Reported By: Jake Horner | Title: Geologist | Signature: Jake Horner | Date: 3-24-06

A-6003-658 (04/03)

APPENDIX D

WELL DEVELOPMENT DATA FOR:

WELL C4948 (2 PAGES)

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